APPENDIX A

NTSC Taboo Interference Mechanisms

APPENDIX A

NTSC TABOO INTERFERENCE MECHANISMS

Intermodulation

Intermodulation interference results from a combination of input signals such that their sums and differences produce spurious frequency products falling within an eleven channel spread. For that reason, Commission rules for NTSC preclude the near location of stations separated by two, three, four or five channels (the first adjacent channel is precluded also but under a more restrictive separation requirement).

Cross modulation

Cross modulation interference involves the same group of channels as intermodulation but the mechanism is different. In cross modulation interference, the modulation of the undesired channel is superimposed on the modulation of the desired channel. The first evidence of such interference usually comes from vertical and horizontal boundaries of the undesired channel showing in the desired channel.

Oscillator

The local oscillator of a television receiver is tuned to a frequency falling into the seventh channel above the desired channel in order to produce beats falling into the intermediate frequency (IF) band running from 41 to 47 MHz. That local oscillator can be considered to be a low power transmitter. In older receivers, sufficient energy from the local oscillator leaked out through the tuner to the antenna that interference could be caused to a nearby receiver tuned to the seventh channel. Therefore, the FCC had limited use of the seventh channel to stations separated by at least 95.7 kilometers (59.5 miles). Modern receivers leak very little of the local oscillator output to the receiving antenna so the general consensus is that the oscillator taboo no longer serves a useful purpose.

IF Beat

When two strong signals are separated by the IF universally employed for NTSC receivers (41 - 47 MHz), the possibility exists that they will beat against each other and produce an interfering signal in the IF amplifier section of the receiver. The range of signals producing this phenomenon falls in the situations where stations are removed in frequency by 7 or 8 channels.

Half-IF

Signals falling in the fourth channel above the desired channel have the potential of beating with the local oscillator tuned to the desired channel to produce a half-IF signal. In the nonlinear circuit of the receiver's first detector, the second harmonic of that half-IF signal can be generated and cause interference to the desired channel.

Image

The local oscillator of a television receiver is tuned to a frequency approximately 47 MHz above the lower edge of the desired channel. When that local oscillator frequency and the desired channel signal encounter the first detector of the receiver, the difference beat falls into the 41 - 47 MHz IF channel. However, an undesired signal above the local oscillator frequency by the same amount that the desired signal is below the oscillator frequency will also produce a signal falling within the receiver's IF pass band. For the visual carrier, the critical channel is fifteen above the desired channel. For the aural carrier, the fourteenth channel above the desired channel is critical.

D R A F T

PRELIMINARY ANALYSIS OF VHF & UHF SPECTRUM SCENARIOS

I. Introduction

Working Party 3, the Spectrum Utilization and Alternatives Working Party, was tasked with examining a constellation of spectrum scenarios to find additional spectrum for use in conjunction with existing channels on either a supplemental or simulcast basis. Specifically, the Working Party selected three groups of spectrum scenarios to investigate within the existing VHF and UHF television allocations. They were:

a. Scenarios that require a 3 or 6 MHz supplementary channel in addition to the basic 6 MHz NTSC channel where the supplementary channel is contiguous to the NTSC channel.

b. Scenarios that require a 3 or 6 MHz supplementary channel in addition to the basic 6 MHz NTSC channel where the supplementary channel is not necessarily contiguous to the base channel but is restricted to the same band, i.e., VHF stations are assigned supplemental VHF spectrum and UHF stations are assigned UHF spectrum.

c. Scenarios that also require a 3 or 6 MHz supplementary channel where the supplementary channel is not necessarily contiguous and could be assigned from either the VHF or UHF bands.

A total of 12 separate spectrum scenarios were investigated. The data used to examine the various scenarios were generated by the FCC Office of Engineering and Technology and given to WP-3 for analysis.

Presented herein is a first-cut analysis of all of the spectrum scenarios completed to date. Section II addresses spectrum availability for ATV systems that propose to use a supplemental channel in conjunction with existing channels to transmit an ATV signal. Section III addresses spectrum availability for ATV systems that propose to use a separate 6 MHz channel to transmit an ATV signal (simulcasting).

II. Analysis

Prior to presenting the analysis, a few comments and observations are in order. First, it is important to recognize that the work completed to date is preliminary and should be treated as such, even though all the scenarios were investigated using the most recent FCC broadcast database --including pending applications, and provisions were made to protect Canadian and Mexican assignments. Second, it is important to emphasize that the statistics presented below are nationwide statistics. These statistics are generally representative of most areas of the country. However, in some areas, particularly in a few major markets, the national statistics may present a more optimistic ATV accommodation assessment than the actual statistics for that area.1/ Finally, it is also important to recognize that the method used to derive these statistics furnishes somewhat less than optimal results. The method is also somewhat skewed toward accommodating VHF licensees first.2/ Refinement of the methodology is possible and could possibly improve the statistics. It is, however, believed that such improvements would not significantly alter the findings presented below.

Description of Methodology

Most of the advanced television systems proposed are still at an early stage of development. Consequently, it is not possible at this stage to determine the susceptibility of each to interference from either NTSC or its own operation.

1/ While major market statistics can and have been extracted from the national statistics, this document elected not to analyze or present findings on the major markets at this time for the following reason: The priority by which the model assigns augmentation channels to existing stations is based on how difficult it is for a station to get additional spectrum relative to its neighboring stations. In a congested area such as the eastern corridor, a station in Baltimore or Frederick, Md. has more neighbors within a specified radius than a station in Washington, D.C. Thus, Baltimore or Frederick, Md. has a better chance of getting an augmentation channel than Washington, D.C., even though Washington is a higher ranked market. The model could (continued...)

Given the absence of actual interference susceptibility data, a generic system-independent method was developed to assess the various spectrum options. The method was developed with two purposes in mind:

1) To quantify the "additional" spectrum capacity at VHF and UHF for an advanced television system under different spectrum scenarios and rank them according to the degree of ATV accommodation.

2) To assist system designers in better understanding the relationship and tradeoffs between availability of spectrum and design of an ATV system.

The method uses minimum separation distance to determine the number of existing TV stations that can be accommodated with supplemental spectrum under the different spectrum scenarios. Studies considered both co-channel and adjacent channel minimum separations, or co-channel alone. The separation distance is the distance between a proposed supplemental channel and its nearest co-channel or adjacent channel operation. The method assumes that the location of the supplemental channel is the same as the station to be accommodated.

For each scenario, statistics relating to the percentage of existing TV stations that can be accommodated at different separation distances were determined for the continental U.S. Table 1 is an example of a distribution of the percentages of existing TV stations that can be accommodated with a non-contiguous 3 MHz channel for different separation distances. In this example, the supplemental spectrum was assigned from either band and 80 kilometer adjacent channel protection was provided to existing stations as well as the new channels. Combined ATV accommodation statistics for VHF and UHF licensees are presented as well as statistics for each band.

1/(Continued) be modified to favor the major markets and ultimately improve the statistics for the major markets at the expense of the smaller markets. For this reason it was felt that this approach should be explored further prior to presenting major market statistics.

2/ The model assigns augmentation channels to existing stations starting with the lowest station's channel number first, *i.e.*, a channel 2 TV station is assigned spectrum before a channel 4 TV station in the same area, and so on.

TABLE 1
3 MHz Non-Contiguous Scenarios with Adjacent Channel Protection

Minimum Separation Distance in Km	Percent of Accommodation VHF	UHF	Total
300	86.0	71.7	77.4
290	89.7	74.0	80.3
280	91.1	77.0	82.7
270	92.4	81.6	85.9
260	93.2	84.3	87.8
250	94.4	87.4	90.2
240	96.6	88.9	92.0
230	96.6	91.2	93.3
220	96.6	93.3	94.8
210	97.7	95.2	96.2
200	98.9	97.3	98.4
190	99.8	97.5	98.6
180	100.0	99.1	99.4
170	100.0	99.8	99.8
160	100.0	100.0	100.0

Appendix A contains the distributions of all the spectrum scenarios examined by WP-3.

Development of the Spectrum Scenarios

Different ATV systems have different spectrum implications. To insure that all these spectrum implications are adequately investigated, the spectrum scenarios developed must broadly reflect the technical attributes of the different candidate systems. However, realizing that the technical attributes of the various ATV systems are not yet known, a generic approach had to be developed to provide spectrum availability data for whatever characteristics the ATV system might have. Rather than developing spectrum scenarios based on the technical attributes of particular systems, they were based on the range of minimum separations covering an entire gamut of interference considerations.

Generally speaking, an ideal supplemental-channel ATV system is one that permits coverage approaching the coverage of existing NTSC service and is rugged enough to overcome the effect of multipath and other degrading factors such as co-channel, adjacent channel, etc., despite relatively low signal-to-interference ratios. To develop such a system within the existing bands, a number of technical objectives must be achieved. Among the most critical ones are:

a) To devise supplementary channels that are benign (from the interference standpoint) to NTSC operations on adjacent channels (level a).

b) To design an ATV system that can be transmitted on non-contiguous spectrum within the same band. This entails the ability to separate an ATV system into two separate components, transmit each component using separate channels -- a 6 MHz channel and a supplemental channel -- that are not contiguous in spectrum and ultimately combine both channels in the ATV receiver (level b).

c) To design an ATV system that can adequately compensate for the effect of multipath caused from transmission of an ATV system on two different bands or on two UHF channels widely spaced in frequency, i.e., the ability of an ATV system to satisfactorily correct for the difference in the phase and amplitude of the two separately transmitted signals, one at UHF and one at VHF or both at UHF, at reception. While it is possible to treat this objective as part of "b", it was felt that the multipath problem is a technically complex one that warrants separate treatment (level c).

Realizing that these objectives might not be achieved by every candidate system, scenarios were developed to assess the spectrum availability for each level described above, including combinations of more than one level.

Results

The data in Appendix A was analyzed to serve different audiences: spectrum managers, system developers, and broadcast engineers.

For spectrum managers, the analysis quantifies the "additional" spectrum capacity at VHF and UHF for the different scenarios and ranks them from best to worst from the standpoint of the number of existing stations accommodated. Such rankings could then be used by spectrum managers to rank the various proponent systems according to the degree of ATV accommodation.

For developers of ATV systems, the analysis identifies the technical objectives they must achieve if they intend to operate within the existing VHF and UHF bands. It also ranks the different technical objectives according to their greatest benefits in terms of ATV accommodation. These rankings should help system designers focus their R&D efforts accordingly.

For the broadcast engineers, the analysis helps in assessing the costs and benefits associated with the different spectrum scenarios in terms of anticipated gains and losses of service, and the technical difficulties they might possibly encounter in the implementation stage of ATV.

To help system designers get a sense of the relative magnitude and tradeoffs between the various scenarios, statistics from a single distance separation study (160 kilometers) were extracted from Appendix A. The 160-kilometer distance (100 miles) was intentionally selected to make the point that under some scenarios a 100% ATV accommodation is achievable. However, one has to recognize that in order for a supplemental channel to effectively operate at a co-channel separation distance of 160 km it must exhibit very robust characteristics, <u>i.e.</u>, the supplemental channel must exhibit <u>considerably</u> more immunity to interference than an NTSC channel. Further along in the analysis another separation distance (200 kilometers) will be selected to examine the elasticity of the various scenarios to changes in separation distance.

Tables 2 and 3 present accommodation statistics for 3 and 6 MHz supplementary channels respectively for a separation distance of 160 km. The statistics are tabulated using the objective levels described earlier. For example, if a system designer was able to achieve all three objectives (levels a, b & c), then the percentages of existing TV stations that can be accommodated are presented on the last row in Tables 2 and 3. On the other hand, if a system designer was unable to achieve any of the objectives, referred herein as "no level", then the accommodation statistics are presented on the first row in tables 2 and 3 and so on.

TABLE 2
3 MHz Supplement

Objective Level	Percent Accommodation VHF	UHF	Total
No level	64.1	85.7	78.0
Level a	68.4	86.7	79.4
Level b	85.6	100.0	94.2
Levels a & b	91.2	100.0	96.4
Levels a & c	100.0	100.0	100.0
Levels a, b & c	100.0	100.0	100.0

TABLE 3
6 MHz Supplement

Objective Level	Percent Accommodation VHF	UHF	Total
No level	48.6	76.0	65.0
Level a	60.3	82.8	73.9
Level b	67.5	98.1	85.8
Levels a & b	80.3	100.0	92.0
Levels a & c	97.5	96.0	96.5
Levels a, b & c	100.0	99.6	99.8

A review of the statistics in Tables 2 and 3 reveals that achieving all the technical objectives, especially objective levels "b" and "c", significantly improve the ATV accommodation statistics at VHF, less so at UHF. If a system designer can achieve all three technical objectives, the accommodation statistics for the 3 and 6 MHz supplemental channels are or approach 100%. Also, comparison of the relative improvement in the statistics for each objective level reveals that achieving objective level "b" (same band, non-contiguous spectrum) offers the greatest improvement in the statistics, followed by objective level "c" (effect of multipath) and to a lesser extent objective level "a" (adjacent channel protection). Ranking the technical objectives based on the largest improvement in ATV accommodation could be useful in that it could help system designers prioritize their R&D efforts along the same lines and focus first on the technical problems that offer the greatest benefits in terms of ATV accommodation.

Comparison of the accommodation statistics for Tables 2 and 3 reveals that at this distance there is no significant difference in the statistics for UHF between 3 and 6 MHz irrespective of which objective level is achieved. The difference is, however, more significant at VHF and depends to a large extent on the objective level achieved. Specifically, if all three objective levels are achieved, there is no difference in the statistics between 3 and 6 MHz. On the other hand, if objective level "c" is not achieved the difference is significant. Putting it in another way, if system designers achieve all three objective levels, the penalty for getting an additional 3 MHz spectrum (for a total of 6 rather than 3 MHz) is <u>minimal</u>.

Tables 4 and 5 present accommodation statistics for 3 and 6 MHz respectively for a separation distance of 200 km.

TABLE 4
3 MHz Supplement

Objective Level	Percent Accommodation		
	VHF	UHF	Total
No level	35.2	70.8	56.4
Level a	37.3	71.8	57.8
Level b	60.2	99.0	83.4
Levels a & b	68.8	99.6	87.4
Levels a & c	98.9	97.3	98.6
Levels a, b & c	99.4	99.1	99.3

TABLE 5
6 MHz Supplement

Objective Level	Percent Accommodation		
	VHF	UHF	Total
No level	27.9	59.5	46.8
Level a	32.0	65.3	52.0
Level b	44.6	92.2	73.0
Levels a & b	51.6	97.0	78.7
Levels a & c	94.1	89.0	90.9
Levels a, b & c	97.7	94.7	95.8

A review of the statistics at this distance reveals that the observations made at 160 km equally apply. Comparing the statistics between the two separation distances reveals that if a system designer achieves all three objective levels the penalty for selecting a 200 km separation distance in terms of ATV accommodation is relatively small. On the other hand, if he cannot achieve all three levels, the penalty is significantly greater at 200 km than at 160 km.

Comparing the statistics between Tables 4 and 5 also reveals that the observations made at 160 km equally apply.

All in all, it appears that from a system design perspective, one can conclude that in order to achieve total or high ATV accommodation for existing licensees one has to achieve all the technical objectives described earlier. One can also conclude that in order to achieve these high accommodation percentages, the supplemental channel must exhibit very robust interference characteristics. Specifically, the ATV supplemental channel must exhibit more immunity to interference than an NTSC system, *i.e.*, accept more interference than an NTSC system and cause less interference to an NTSC system.

Examining the data from a purely ATV accommodation perspective, one can rank the 12 different scenarios from best to worst from the standpoint of the number of existing stations that can be accommodated. The results are presented in Table 6. This ranking is generally applicable to all separation distances investigated.

TABLE 6
Spectrum Scenario Ranking Based on Percent Accommodation at VHF & UHF

Best	3 MHz non-contiguous with cochannel only protection
	3 MHz non-contiguous with co & adj. ch. protection
	6 MHz non-contiguous with cochannel only protection
	3 MHz non-contiguous same band with coch. protection
	6 MHz non-contiguous with co & adj. ch. protection
	3 MHz non-contiguous same band, co & adj. protection
	6 MHz non-contiguous same band, co ch. protection
	6 MHz non-contiguous same band, co & adj. protection
	3 MHz contiguous with cochannel only protection
	3 MHz contiguous with co & adj. channel protection
↓	6 MHz contiguous with cochannel only protection
Worst	6 MHz contiguous with co & adj. channel protection

Similar ranking can be developed for VHF and UHF separately.

III. Simulcasting

The use of simulcasting to introduce an improved service to the public is not a new concept. Simulcasting has been used in the past by the radio community to transmit the same programming over different channels in the AM and FM bands, with one being of higher quality.

For introducing an ATV service, simulcasting might be an attractive option in that it allows ATV systems that are not compatible with existing receivers to operate within the existing broadcast bands without disrupting the existing NTSC service. Basically, ATV systems requiring 6 MHz of spectrum perhaps could effectively operate within the existing VHF and UHF broadcast bands in the same fashion as a 6 MHz supplemental channel would. The same ATV accommodation statistics described above can be used to investigate the spectrum scenarios for simulcasting.

The main difference between a 6 MHz simulcast channel and a 6 MHz supplemental channel is that the simulcast channel may not need to overcome the same technical problems or milestones as a supplemental channel. Specifically, a simulcast channel does not need to be concerned about combining two non-contiguous channels or the effect of multipath. The only technical problem of concern is whether the simulcast channel can operate in the existing NTSC environment on adjacent channels. The absence of additional constraints considerably simplifies the ATV design and transmission questions.

As to the different scenarios for simulcasting, there are but two. The first is the ability to design an ATV system that operates on the adjacent channels of existing NTSC operation without degrading its service (level d). The second is the opposite of the previous scenario (no level). Tables 7 & 8 present the ATV accommodation statistics for the two scenarios at two different separation distances (160 and 200 km). Note that objective level "d" under the simulcast plan is equivalent to level "a, b & c" under the augmentation channel plan.

TABLE 7
6 MHz Simulcast
(160 km)

Objective Level	Percent Accommodation VHF	UHF	Total
No level	97.5	96.0	96.1
Level d	100.0	99.6	99.8

TABLE 8
6 MHz Simulcast
(200 km)

Objective Level	Percent Accommodation VHF	UHF	Total
No level	94.1	89.0	90.9
Level d	97.7	94.7	95.8

A review of the ATV accommodation statistics reveals that achieving objective level "d" slightly improves the statistics at both separation distances. And, that if objective level "d" is not achieved, the penalty in terms of ATV accommodation is relatively small.

All in all, one can conclude that a simulcast plan achieves total or high ATV accommodation for existing licensees with less technical constraints as with the previous plan. Here again, in order to achieve these high accommodation percentages, the simulcast channel must exhibit very robust interference characteristics.

IV. Future Spectrum Studies

Future spectrum studies will focus on two areas. The first area will examine the availability of spectrum assuming the reintroduction of various combinations of the taboos. These studies will quantify the impact partial relaxation of the taboos might have on spectrum availability. The second area will examine the availability of spectrum under a new plan -- commonly referred to as repacking. The repacking plan will encompass a number of spectrum scenarios along the same lines as the ones developed for the studies herein.

First, MST does not endorse the concept of repacking of the UHF television band. Nonetheless, from the standpoint of spectrum availability we believe the repacking studies should be pursued so that the advisory committee and the FCC may evaluate spectrum availability under the entire gamut of assumptions. The choice of one of those assumptions as to the preferred path involves a number of public policy issues and decisions that must then be thoroughly evaluated.

Second, it should be clear from the preceding discussion that the greatest availability of spectrum without repacking occurs under the assumptions used for the studies presented here, i.e., no taboos. Consequently, the potential for improvement in receiver immunity to the various taboo interference mechanisms should be a topic of immediate concern and investigation.

Appendix A

TABLE 1 - APPROXIMATE UPPER BOUND ON PERCENTAGE OF STATIONS TO WHICH CONTIGUOUS SUPPLEMENTAL SPECTRUM CAN BE ASSIGNED WITH 80 KILOMETERS SEPARATING ADJACENT CHANNELS

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	SIX - MHz TOTAL PERCENT
300	3.5	26.5	16.7
290	4.3	28.7	18.9
280	5.7	30.9	20.8
270	7.4	34.9	23.8
260	8.9	37.2	25.9
250	10.9	40.8	28.8
240	12.0	42.8	30.5
230	13.9	46.6	33.5
220	16.7	51.6	37.6
210	22.0	55.3	41.9
200	27.9	59.5	46.8
190	33.7	64.3	52.0
180	38.0	68.0	55.0
170	42.6	71.2	59.7
160	48.6	76.0	65.0

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	THREE - MHz TOTAL PERCENT
300	5.5	34.3	22.7
290	6.3	37.1	24.7
280	7.9	39.6	26.8
270	10.0	44.6	30.6
260	12.0	48.3	33.6
250	14.2	51.9	36.7
240	15.4	54.1	38.5
230	17.7	57.5	41.4
220	20.8	62.3	45.6
210	27.5	66.3	50.6
200	35.2	70.5	56.2
190	42.4	74.8	61.7
180	49.7	78.6	66.9
170	56.2	81.3	71.1
160	64.1	85.7	76.9

TABLE 2 - UPPER BOUND ON PERCENTAGE OF STATIONS TO WHICH CONTIGUOUS SUPPLEMENTAL SPECTRUM CAN BE ASSIGNED IN THE ABSENCE OF ADJACENT-CHANNEL RESTRAINTS

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	SIX - MHz TOTALPERCENT
300	4.7	30.4	20.1
290	5.5	32.7	21.8
280	6.9	35.2	23.8
270	8.9	39.9	27.5
260	10.6	43.1	30.1
250	12.6	46.4	32.9
240	14.0	48.4	34.7
230	15.9	52.1	37.6
220	18.4	57.3	41.9
210	25.2	61.1	46.7
200	32.0	65.3	52.0
190	39.5	70.5	58.1
180	46.0	74.5	60.5
170	52.0	77.9	67.6
160	60.0	82.8	73.9

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	THREE - MHz TOTAL PERCENT
300	6.4	35.4	23.6
290	7.2	38.2	25.6
280	8.8	40.7	27.8
270	10.9	45.7	31.6
260	12.9	49.3	34.5
250	15.2	53.1	37.8
240	16.7	55.1	39.6
230	18.9	58.4	42.4
220	22.2	63.4	46.8
210	29.2	67.5	52.0
200	37.3	71.8	57.8
190	45.5	75.8	63.5
180	52.8	79.5	68.7
170	60.0	82.3	73.2
160	68.4	86.7	79.4

A P P E N D I X   B

Preliminary Analysis

Part I

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PRELIMINARY ANALYSIS

OF VHF AND UHF

SPECTRUM SCENARIOS

PART I

(AUGMENTATION & SIMULCAST)

July 1989

PS/WP-3 00
V. Tawil

Executive Summary

This document presents a first-cut analysis of the data generated by the FCC Office of Engineering and Technology previously given to the Spectrum Utilization and Alternatives Working Party for analysis. The data was compiled to investigate the potential for implementing an advanced television (ATV) service within the existing VHF and UHF television allocations.

Two different plans were used to assess the availability of spectrum for a terrestrial ATV service. The first is an augmentation channel plan where existing TV stations use additional spectrum, available under certain assumptions, to transmit an ATV signal. The second is a simulcast plan where additional spectrum is used to transmit an independent ATV signal separate from the existing TV channels. Comments relating to the advantages and disadvantages for each plan are presented.

The analysis is intended to serve three audiences; spectrum managers, system developers, and broadcast engineers. For spectrum managers, the analysis quantifies the "additional" spectrum capacity at VHF and UHF under a number of assumptions and ranks the various spectrum scenarios strictly from an ATV accommodation/spectrum efficiency perspective. For developers of ATV systems, the analysis assists them in better understanding the relationship and tradeoffs between the availability of spectrum and the design of an ATV system. Broadcast engineers should use this analysis to begin assessing the benefits and costs of the two approaches discussed.

The document contains a number of findings and observations. These findings could be consolidated into two major findings:

1) Regardless of which plan is used to assess the availability of spectrum at VHF and UHF, in order to achieve total or high ATV accommodation for existing licensees, an ATV system must exhibit <u>very robust</u> interference characteristics, <u>i.e.</u>, accept more interference than an NTSC system and cause less interference to an NTSC system.

2) The ATV accommodation statistics for the most spectrally efficient scenario under an augmentation channel plan is only slightly better than the most spectrally efficient spectrum scenario under a simulcast plan. However, the technical complexities of designing and implementing a terrestrial ATV system under a channel augmentation plan are significantly greater than under a simulcast plan. This finding suggests that a simulcast plan might be worthy of consideration as a viable alternative within the existing broadcast allocations if broadcasters use more than their current channels to provide an ATV service.

TABLE 3 - APPROXIMATE UPPER BOUND ON PERCENTAGE OF STATIONS TO WHICH SAME-BAND SUPPLEMENTAL SPECTRUM CAN BE ASSIGNED WITH 80 KILOMETERS SEPARATING ADJACENT CHANNEL STATIONS

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	SIX - MHz TOTAL PERCENT
300	7.2	59.2	38.2
290	9.0	63.0	41.2
280	10.7	66.0	43.6
270	13.0	69.8	46.9
260	16.5	72.0	49.6
250	20.1	76.3	53.6
240	22.3	79.3	56.3
230	26.6	83.0	60.2
220	30.8	86.3	63.9
210	38.3	88.8	68.4
200	44.6	92.2	73.0
190	51.6	93.3	76.5
180	56.2	95.1	79.3
170	60.6	96.6	82.0
160	67.5	98.1	85.7

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	THREE - MHz TOTAL PERCENT
300	10.3	78.1	50.8
290	12.4	81.8	60.2
280	15.1	83.5	55.9
270	18.1	87.0	59.2
260	21.9	89.1	61.9
250	26.4	91.2	65.1
240	30.1	93.8	68.1
230	35.7	94.9	71.0
220	41.2	96.4	74.1
210	51.7	97.8	79.1
200	60.2	99.0	83.4
190	68.1	99.2	86.6
180	73.2	100.0	89.1
170	79.9	100.0	91.8
160	85.6	100.0	94.2

TABLE 4 - APPROXIMATE UPPER BOUND ON PERCENTAGE OF STATIONS TO WHICH SAME-BAND SUPPLEMENTAL SPECTRUM CAN BE ASSIGNED IN THE ABSENCE OF ADJACENT CHANNEL RESTRAINTS

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	SIX - MHz TOTAL PERCENT
300	8.3	64.9	42.1
290	10.3	68.8	45.2
280	13.0	72.2	48.3
270	15.8	75.8	51.6
260	19.2	78.7	54.7
250	22.7	82.2	58.2
240	25.2	86.3	61.7
230	30.5	89.7	65.8
220	35.0	92.7	69.4
210	43.6	94.2	73.8
200	51.6	97.0	78.7
190	61.3	98.0	83.2
180	66.9	99.5	86.3
170	72.6	99.6	88.6
160	80.3	100.0	92.0

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	THREE - MHz TOTAL PERCENT
300	12.9	81.5	53.8
290	15.4	85.3	57.1
280	18.6	90.6	61.5
270	22.5	92.3	64.2
260	27.3	94.8	67.5
250	32.1	98.0	71.4
240	36.0	96.7	72.2
230	42.2	98.0	75.5
220	47.7	98.9	78.2
210	58.3	99.6	82.9
200	68.8	99.6	87.4
190	76.4	100.0	90.4
180	81.0	100.0	92.3
170	86.7	100.0	94.6
160	91.2	100.0	96.4

TABLE 5 - APPROXIMATE UPPER BOUND ON PERCENTAGE OF STATIONS TO WHICH ADDITIONAL UHF OR VHF SPECTRUM CAN BE ASSIGNED WITH 80 KILOMETERS SEPARATING ADJACENT CHANNELS

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	SIX - MHz TOTAL PERCENT
300	76.0	50.7	60.8
290	79.7	52.5	63.4
280	81.8	55.9	66.2
270	83.1	61.7	70.2
260	84.3	65.5	72.9
250	85.3	69.1	75.5
240	88.4	72.4	78.8
230	89.4	76.2	81.4
220	91.0	82.5	85.8
210	92.3	85.5	88.1
200	94.1	89.0	90.9
190	95.2	90.5	92.3
180	96.9	92.3	94.1
170	97.3	94.0	95.2
160	97.5	96.0	96.5

MINIMUM SEPARATION DISTANCE KILOMETERS	VHF	UHF	THREE - MHz TOTAL PERCENT
300	86.0	71.7	77.4
290	89.7	74.0	80.3
280	91.1	77.0	82.7
270	92.4	81.6	85.9
260	93.2	84.3	87.8
250	94.4	87.4	90.2
240	96.6	88.9	92.0
230	96.5	91.2	93.3
220	96.6	93.6	94.8
210	97.7	95.2	96.2
200	98.9	97.3	98.4
190	99.8	97.5	98.6
180	100.0	99.1	99.4
170	100.0	99.8	99.8
160	100.0	100.0	100.0